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Estado nutricional e fatores associados ao excesso de peso e obesidade em idosos de acordo com a classificação de Lipschitz – Resultados do projeto *Nutrition UP 65*

Nutritional status and associated factors with overweight/obesity in older adults according to Lipschitz classification – Results from the *Nutrition UP 65* project

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Resumo

Introdução: Recentemente, assiste-se a um crescente envelhecimento da população portuguesa. Com o avançar da idade surgem alterações fisiológicas, que em conjunto com fatores sociais e diferentes estilos de vida podem condicionar o estado nutricional do idoso. Assim, é essencial a sua monitorização de forma a criar as medidas de intervenção mais adequadas.

Objetivo: Avaliar o estado nutricional e fatores associados ao excesso de peso segundo a classificação de Lipschitz em idosos portugueses do projeto *Nutrition UP 65*.

Desenho: Estudo observacional de desenho transversal.

População e métodos: Analisou-se uma amostra de 1496 portugueses ≥ 65 anos. Os participantes foram classificados, segundo a classificação de IMC proposta por Lipschitz, como tendo baixo peso, normal ou excesso ponderal. A associação entre o IMC e características dos indivíduos foi analisada através de regressão logística.

Resultados: Do total da amostra, 4.2% apresentou baixo peso, 27.9% normal e 67.9% excesso de peso, sendo esta prevalência de excesso de peso maior nas mulheres do que nos homens. Má perceção do estado de saúde e consumo excessivo de bebidas alcoólicas associaram-se positivamente a um maior risco de excesso ponderal. Em contrapartida, maior grau de escolaridade, comprometimento cognitivo, risco de desnutrição ou desnutrição, baixa atividade física, tabagismo e sarcopenia associaram-se negativamente com o excesso de peso.

Conclusão: Os nossos resultados mostram que mais de 60% dos idosos portugueses apresentam excesso de peso, e que este se associa com características de várias índoles (socioeconómicas, estilos de vida, funcionais e de saúde), o que

confirma a necessidade de desenvolver programas efetivos de modificação de estilos de vida e promoção de saúde.

Palavras – chave

Estado nutricional, Índice de massa corporal, idosos, Portugal

Abstract

Introduction: Lately, there has been a growing aging of the Portuguese population. Aging is associated with physiological changes, which together with social factors and different lifestyles can condition the nutritional status of the older adults. Monitoring nutritional status is therefore essential in order to create the most appropriate intervention measures.

Aim: Evaluate the nutritional status and overweight's associated factors using the Lipschitz classification in Portuguese older adults from the *Nutrition UP 65* project.

Design: Cross-sectional observational study.

Participants and methods: A national sample of 1496 individuals ≥ 65 years old was analyzed. Participants were classified according to the Body Mass Index classification proposed by Lipschitz as being underweight, normal or overweight. The association between BMI and individuals' characteristics was analyzed through a logistic regression.

Results: Of the total sample, 4.2% presented underweight, 27.9% normal and 67.9% overweight. The proportion of overweight was higher in women than in men. Poor perception of health status and excessive alcoholic beverages consumption were related with increased odds of overweight. On the other hand, higher education level, cognitive impairment, risk of undernutrition and undernutrition, low physical activity, smoking and sarcopenia were associated with lower odds of being overweight.

Conclusion: Our results show that more than 60% of Portuguese older adult present overweight, which is associated with different kind of factors (socioeconomic, lifestyles, functional and health). Thus, it is necessary to develop effective lifestyle modification and health promotion programs.

Key – words

Nutritional status, Body Mass Index, older adults, Portugal

Acronyms

BMI: Body Mass Index

CI: Confidence Interval

FFM: Fat free mass

FM: Fat mass

IAN-AF: National Food and Physical Activity Survey

INSEF – 2015: National Health Survey with Physical Examination: Portuguese Health Status in 2015

IPAQ: International Physical Activity Questionnaire

MET-min: Metabolic equivalent of task per minute

MMSE: Mini Mental State Examination

MNA-SF: Mini-Nutritional Assessment – Short Form

NUTS II: Nomenclature of Territorial Units for Statistical purposes

OR: Odds ratio

WHO: World Health Organization

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Introduction

Around the world, the number of older people is increasing dramatically, due to the increase of average life expectancy and socioeconomic development.[1] Specifically, in Europe it is expected that in 2060 those aged 65 and over will represent 28% of the population and those aged 80 and over will represent 12% of the population.[2] In Portugal, in 2016 the life expectancy at birth was 77.7 years for men and 83.4 for women[3] and it is expected that rise to 84.5 and 89.2 years for men and women, respectively, in 2060.[2] Data from the last national Census in 2011 revealed that 19% of the Portuguese population was aged 65 and over.[4]

Aging is frequently associated with changes in body composition, and body weight usually tends to increase during life up till the age of 70-80 years. Still, both underweight and obesity are often observed among older adults.[5] In fact, nutritional status in the older adults can be affected by many physiological, cognitive, social and economic factors.[6]

With advancing age it is observed an accumulation of changes in a individuals' physiology.[7] Changes in body composition include a gradual decrease of fat free mass (FFM), due to loss of muscle mass, bone mass and total body water, whereas fat mass (FM) increases. It is also observed a redistribution of body FM, with a greater increase of intra-abdominal, intra-muscular and intra-hepatic fat.[8-10] Furthermore, during aging process, there is a decrease in the total energy expenditure due to the reduction of physical activity, resting metabolic rate and post-prandial thermogenesis.[8, 11, 12] Besides, hormonal changes related with aging process, like the decline in growth hormone and testosterone production, can enhance the accumulation of fat, the reduction of FFM and disturb the energy balance.[8, 12]

It seems that socio-demographic factors interplay with lifestyles to drive obesity in older people. Current studies show that low socioeconomic status, low education level and living in rural areas are associated with a larger prevalence of obesity.[13-15] Tobacco use, alcohol intake and physical activity are also conditions that may influence obesity.[16, 17] Thus, social iniquities and cultural practices are likely to promote differences in the prevalence of obesity across some countries.[13, 17]

Nutritional status plays an important role in the quality of life and health of older adults. On one hand, obesity is associated with increasing risk of certain chronic health conditions, including hypertension, diabetes, dyslipidemia, cardiovascular disease and some cancers.[12, 18-20] It can also exacerbate age-related decline in physical function[11, 12] and it can lead to disabilities of activities of daily living, frailty, chronic pain and impaired quality of life.[9, 11, 21] Furthermore, the prevalence of sarcopenic obesity increases with age which results in worse physical function and increased risk of disability. [18] On the other side, underweight is also related with adverse consequences like impaired muscle function, immune dysfunction, more hospitalizations and an increased mortality.[22] Moreover, low body mass index (BMI) may be an early event in cognitive decline in later life.[23]

To assess nutritional status in the clinical practice and epidemiological studies, the BMI is one of the most commonly used indicator because of its low cost and relative ease of measurement.[24]

However, BMI is dependent of age, gender and ethnicity,[25] and it does not account for the variation in body fat distribution.[26] In older adults, BMI can be a poor measure of adiposity, because of the fact that these individuals lose height as they age.[24]

According to World Health Organization (WHO), the cutoff points that must be used to classify nutritional status are the following: underweight: BMI < 18.5 kg/m^2; normal weight: BMI between [18.5; 25.0[kg/m^2; pre-obesity: BMI between [25.0; 30.0[kg/m^2; obesity: BMI ≥ 30 kg/m^2.[27] Nowadays, the use of this classification is being debated, mainly among the older adults, because of the redistribution of body fat and the decrease of muscle mass, bone density and body water that occurs with the aging process.[28, 29] In this sense, some clinicians have felt the need to use in their practice the cutoff values proposed in 1994 by Lipschitz, for people aged 65 years and over. Underweight is defined as a BMI < 22.0 kg/m^2, normal weight as a BMI between 22.0 – 27.0 kg/m^2 and overweight with a BMI > 27.0 kg/m^2.[30]

Therefore, it is extremely important to assess nutritional status of older population and to identify the associated factors in order to develop specific public health interventions, to prevent illness and to promote health in the older adults.

The *Nutrition UP 65* aims to decrease nutritional inequalities among Portuguese older adults.[31]

Aim

The aims of this study were to evaluate the nutritional status and to identify overweight's associated factors in a sample of Portuguese older adults from the *Nutrition UP 65* project, using the Lipschitz classification of body mass index.

Participants and methods

Study design and sampling

A cross-sectional observational study was conducted in Portugal in a sample of 1500 Portuguese older adults (≥ 65 years old), between December 2015 and June 2016. To achieve a nationally representative sample of the older Portuguese

population, a random, stratified, and clustered sampling approach was adopted using data from Census 2011, concerning sex, age, educational level and regional area defined in the Nomenclature of Territorial Units for Statistical purposes (NUTS II).

Only individuals with Portuguese nationality and current tax residence in Portugal were considered to be Portuguese, and they could participate in the study if they were aged 65 years or more. Those eligible to participate were contacted via home approach, telephone, or via institutions by the interviewers, to receive information about the intents and procedures of the study, and to be invited to participate. The sample was composed of community-dwelling older adults and 5% of older individuals in nursing homes, the proportion that was described for Portuguese population.[4]

More detailed information regarding methodology of the *Nutrition UP 65* project was previously disclosed.[31]

Ethics

This research was directed in accordance with the Declaration of Helsinki, and the study protocol was approved by the Ethics Committee of the department of "Ciências Sociais e Saúde" (Social Sciences and Health) from the "Faculdade de Medicina da Universidade do Porto" (PCEDCSS – FMUP 15/2015) and by the Portuguese National Commission of Data Protection (9427/2015). All participants, or two representatives per participant in case of cognitive impairment, gave their written informed consent.

Data collection

Sociodemographic, lifestyle, clinical and nutritional status and cognitive performance data were collected using a structured questionnaire. Anthropometric data was also gathered by eight previously trained registered nutritionists.

Sociodemographic data comprised questions about sex, date of birthday, education, marital status, household income, regional area and residence type. The regional areas used are defined in NUTS II: Alentejo, Algarve, Azores, Lisbon Metropolitan Area, Centre, Madeira and North.[32] Educational level was determined by the number of completed school years.

Lifestyle was evaluated by information on physical activity practice, smoking habits and alcoholic beverages consumption. Physical activity was assessed by the short form of the International Physical Activity Questionnaire (IPAQ), which includes activities completed during the 7 days before the interview.[33] Data from the IPAQ was converted to metabolic equivalent of task per minute (MET-min) and median values were calculated for walking, moderate-intensity and vigorous-intensity activities using specific formulas. Total physical activity was defined as the sum of walking + moderate + vigorous MET-min/week scores,[34] and energy expenditure was computed from MET-min/week scores.[33] In relation to alcoholic beverages consumption, participants were asked if they consumed it and in case of “yes” they were also asked about “how many drinks/day?”. Cognitive performance was assessed by the Portuguese version of the Mini Mental State Examination (MMSE).[35] To identify cognitive impairment, the cutoff scores used were: ≤15 points for participants with no education; ≤22 points for 1-11 years of school completed; and ≤27 points for individuals with more than 11 years of school completed. Data regarding subjective general health were gathered using questions from the Portuguese National Health Survey (2005-2006)[36]. Participants classified their health status as very good, good, moderate, bad or very bad.

Anthropometric measurements were collected following standard procedures.[37] Standing height was obtained with a calibrated stadiometer (Seca 213, Hamburg, Germany) with 0,1 cm resolution. For participants with visible

kyphosis or when it was impossible to measure standing height due to individuals' paralysis, mobility or balance limitations, height was obtained indirectly from non-dominant hand length (in centimeters), measured with a calibrated paquimeter (Fervi Equipment, Italy) with 0,1 cm resolution.[38] Body weight (in kilograms) was measured with a calibrated portable electronic scale (Seca 803) with 0,1 kg resolution, with the participants wearing light clothes. When it was not possible to weigh a subject, because of the previously described reasons that prevented standing height measurement, body weight was estimated from mid-upper arm and calf circumferences.[39] Mid-upper arm, calf and waist circumferences were measured with a metal tape from Lufkin (USA), with 0,1 cm resolution. Triceps skinfold thickness was obtained using a Holtain Tanner/Whitehouse skinfold caliper with 0,2 millimeter resolution. Non-dominant hand grip strength (HGS) was measured with a calibrated Jamar Hand Dynamometer (Sammons Preston), as recommended by the American Society of Hand Therapists.[40] Body mass index (BMI) was calculated using the standard formula: [body weight (kg)/stature^2 (m)].

The Mini-Nutritional Assessment – Short Form (MNA-SF) was applied to identify participants at risk of undernutrition and undernourished.[41, 42]

Frailty was evaluated according to Fried et al[43], which involves the assessment of five criteria: unintentional weight loss in the previous year, weakness, evaluated as low HGS (adjusted for gender and BMI), poor endurance and energy evaluated as exhaustion, slowness (walking time measurement adjusted for gender and standing height), and low physical activity (energy expended per week, adjusted for gender). If one or two of these criteria were present, the individual was characterized as pre-frail. Frailty was defined as the presence of three or more criteria.[43] Sarcopenia includes both low muscle mass and low muscle strength, or diminished physical performance. [44] Muscle mass was obtained based on: body fat

free mass = body weight – body fat mass. Brozek equation was used to convert body density in fat mat mass[45], and body density was estimated based on triceps skinfold thickness.[46] Muscle strength was evaluated by hand grip strength (adjusted for gender and BMI) and physical performance by gait speed. Pre-sarcopenic individuals present only reduced muscle mass. Sarcopenia is indicated by low muscle mass plus one of the other two criteria. Severe sarcopenia includes all the three criteria.[31]

Variable definition

Age was categorized into 65-69 years, 70-74 years, 75-79 years and ≥ 80 years. Household income was summarized as ≤ 499 €, 500-999€ and ≥ 1000 €. From all the subjects, 51.4% did not know or preferred not to declare their income and they were allocated into another category. Marital status was categorized as single, divorced or widowed and married or in a common-law marriage. The categories used for education level were: 0 years of schooling, 1-3 years, 4 years and ≥ 5 years of schooling, which comprised second cycle (6 years of schooling), third cycle (9 years), secondary (12 years), post-secondary (>12 years of schooling but no higher education) and higher education. Residence type was defined as home or institution.

In relation to physical activity, participants were organized as either presenting low physical activity (<383 kcal/week for men and <270 kcal/week for women), or as presenting normal levels (≥383 kcal/week for men and ≥270 kcal/week for women).[43] Concerning to alcoholic beverages consumption, moderate ingestion was defined as 1 drink/day for women and as 1 or 2 drinks/day for men, while excessive consumption was expressed as ≥ 2 drinks/day for women and as ≥3 drinks/day for men.[47]

Cognitive performance was dichotomized in “normal” and “impairment”. Self-perception of health was divided in three categories: very good/good, moderate and

bad/very bad. Regarding BMI, subjects were classified according to Lipschitz classifications: underweight: < 22.0 kg/m^2; normal weight: 22.0 – 27.0 kg/m^2 and overweight: > 27.0 kg/m^2.[30] Due to only 1.3% of individuals classified as undernourished by MNA-SF tool, this variable was dichotomized into two groups (not undernourished and at risk of undernutrition/undernutrition). Frailty and sarcopenia were divided into two categories, considering their presence or absence.

Statistical analysis

Categorical variables were reported as frequencies.

According to the BMI, participants were compared for numerous sociodemographic, lifestyle and clinical characteristics using Pearson X^2 test for categorical variables. Due to four missing records, only 1496 individuals were included. Besides, due to a large disparity of the number of participants in each BMI category and because of the most are found in “overweight” (67.9%), individuals with underweight (4.2%) and normal weight (27.9%) were grouped into one class (non-overweight). Then, to identify the independent factors associated with overweight it was conducted a multivariable logistic regression. Only 1485 participants had complete data for all variables analyzed, so only those were included. Odds ratio (OR) and respective 95% Confidence Intervals (CI) were calculated. The following parameters were considered: sex (dichotomous), age (categorical), regional area (categorical), residence (dichotomous), education (categorical), marital status (dichotomous), self-perception of health (categorical), cognitive performance (dichotomous), MNA-SF (dichotomous), physical activity (dichotomous), smoking habits (dichotomous), alcoholic beverages (categorical) and sarcopenia (dichotomous). Results were considered significant when p<0,005. Data analyses were performed using IBM SPSS Statistics version 25.

Results

The characteristics of the 1496 participants, 58.2% (n=871) women and 41.8% (n=625) men with a median age of 74 years old, ranging from 65 to 100 years old, according to BMI (underweight, normal weight and overweight) are presented in appendix A. Within this sample, using the Lipschitz BMI cut offs, 4.2% of subjects were underweight (n=63), 27.9% had normal weight (n=417) and 67.9% were overweight (n=1016).

The prevalence of overweight was higher in women (61.3%). Concerning to regional area, older adults living in North presented higher proportion of overweight (32.1%) and the higher prevalence of individuals with underweight was seen in Centre (30.2%). Regarding education level, participants with 4 years of schooling presented higher proportion of overweight (50.1%). In relation to cognitive performance, people without cognitive impairment were more overweight (94.6%) than those with cognitive impairment (5.4%). Considering self-perception of health, 50,6% of overweight subjects rated their health status as moderate. According to nutritional status (MNA-SF), individuals not undernourished had higher levels of overweight (86.3%). Furthermore, people below the recommendations for physical activity and non-smokers were more likely to be overweight (69.5% and 97.1% respectively). According to alcoholic beverages consumption, the higher prevalence of overweight was observed in non-drinkers category (64.1%). Concerning sarcopenia, 94% of overweight people did not present this condition.

Logistic regression data are displayed in appendix B.

Using crude analysis, being man reduced 32.6% the odds of overweight compared to being woman. In the adjusted regression model, the variable lost statistical significance (p=0.062).

Regarding education level, participants with 5 or more years of schooling had lower odds of being overweight than those with no formal years of schooling. After adjusted the regression model, this effect preserved its statistical significance (OR=0.581; 95% CI: 0.366 – 0,924; p=0.022). In addition, cognitive impairment was associated with lower odds of being overweight, after conducting unadjusted and adjusted analysis (OR=0.597; 95% CI: 0.393 – 0.906; p=0.015 and OR=0.535; 95% CI: 0.336 – 0.853; p=0.009, respectively). Concerning health self-perception, subjects who classified it as moderate and bad or very bad had higher odds of overweight than those who rated it like good or very good. In adjusted regression model, only people who rated their health as bad or very bad preserved statistical significance (OR=1.656; 95% CI: 1.143 – 2.398; p=0.008). According to nutritional status, subjects at risk of undernutrition and undernourished had decreased odds of 39.8% and 50.5% of being overweight, considering crude data and adjusted regression model, respectively. Moreover, individuals with low physical activity practice presented lower odds of overweight in both unadjusted and adjusted analysis (OR=0.701; 95% CI= 0.546 – 0.900; p=0.005 and OR=0.609; 95% CI=0.454 – 0.816; p=0.001, respectively). Besides, smoking decreased 66,8% the odds of overweight. After adjusted analysis, this variable conserved statistical significance (OR=0.360; 95%CI: 0.211 – 0.615; p< 0.001). In relation to alcoholic beverages consumption, only considering the adjusted model this variable had statistical significance, being that, having an excessive ingestion was associated with higher odds of being overweight comparatively to non-consumption of alcohol (OR=1.805; 95% CI: 1.152 – 2.829; p=0.010). Finally, sarcopenic older adults presented 79.1% less odds of overweight than those at normal category. After conducting adjusted model, the statistical significance was remained (OR=0.194; 95%CI: 0.135 – 0.279; p< 0.001).

Discussion

According to Lipschitz BMI classification more than two thirds of the participants were overweight, which reflects the importance of considering this fact as a public health concern for the country. Using WHO cutoffs, high prevalence of pre-obesity and obesity in Portuguese older adults was also reported in “National Health Survey with Physical Examination: Portuguese Health Status in 2015”, *INSEF-2015*, particularly 41.8% of participants aged between 65 and 74 years old were obese and 39.5% pre-obese[48] and in “National Food and Physical Activity Survey”, *IAN-AF 2015-2016,* revealing a prevalence, weighted for the distribution of the Portuguese population, of 39.2% of obesity and 41.8% of pre-obesity for people aged 65 to 84 years old. [49] In all, these values are higher than those we found, due to the use of WHO classification of BMI. Studies in Brazilian older adults, that used Lipschitz classification, also showed a higher prevalence of overweight, although not so high as the present study (45%[50] and 48%[51]). The higher prevalence of overweight in women that we found is consistent with results from other studies developed in Brazil, using the same classification of BMI.[50-52] This can possible be explained by the fact that women tend to add more visceral fat and have a larger life expectancy. Other possible cause is menopause, usually accompanied of weight and adiposity gain.[53-55]

Concerning education level, it is observed that having 5 or more years of education is inversely associated with overweight. That was also found for Portuguese women [56], with the difference of this study considering not only older adults but also adults and using the WHO classification to categorize obesity. On the other hand, previous research shows that people with lower education are more likely to be overweight or obese. An investigation conducted in Portugal between 2008 and

2009 revealed that female older adults with the lower education level presented higher odds for obesity (OR=2.56), considering WHO BMI cut off points.[14] *IAN-AF 2015-2016* and *INSEF-2015* also reported greater proportion of overweight and obesity between the individuals less educated.[48, 49] Similar results were also reported for adults in other Europeans countries. [57, 58] Educational level and income are usually correlated factors, which may lead to distinct accessibility to food products and contribute to inequalities in nutritional status. Moreover, the most educated people are possibly more informed about more nutritious food, becoming more aware of their food choices.

In addition, in the present study, individuals with cognitive impairment have a decreased odds of being overweight. Naruishi et al.[23] recently found significant associations of low BMI in older adults with higher risk of cognitive impairment, which makes in part our results predictable.

Concerning self-perception of health status, the worst perception was positively associated with overweight. One study conducted with Brazilian older adults (≥ 60 years) also verified that obese individuals perceived their health worse than those in normal weight range.[59]

In relation to nutritional risk, overweight participants were classified mainly as not undernourished, and after applying logistic regression we found an inverse association between risk of undernutrition and undernourished with overweight. Still, MNA can be used also in older obese people due to possibility of these can present poor quality diets and micronutrient deficiencies. MNA tool not only considers BMI to determine malnutrition but also other factors, as presence of depression and lack of mobility, which can be present in overweight people.[60] Obese older adults at risk for

malnutrition were found in previously investigation[61], which reflects the need for caution when obesity was assessed, as this risk may be neglected.

Concerning physical activity, the majority of studies reports higher likelihood of obesity between sedentary people [51, 59, 62, 63]. However, the present results show that being below the recommendations for physical activity is a protective factor for obesity. That may be biased due to the fact that 71.7% of our sample has low physical activity practice.

In this study, smoking was negatively associated with overweight. Nascimento et al.[50] found similar results using the Lipschitz classification (OR=0.3; 95%CI: 0.1-0.6). This effect may be explained by the fact that nicotine is an appetite suppressant and metabolic stimulant,[64] suggesting that smoking cessation may lead to weight gain.[65] In Portugal, recent data show that the proportion of smokers is decreasing [66], and if the association between smoking and weight is strong, possibly the falling rate of smokers have contributed to the increase in overweight.

Excessive alcohol consumption was positively associated with higher odds of overweight, which was predictable due to the higher energetic intake that this entails. Muga et al. also verified that among Taiwan middle-aged and older adults those who drinking alcohol were more likely to be overweight or obese.[67] In Portugal, the consumption of alcohol beverages is higher in the older adults group [49], which can lead to an increasing trend of weight gain. On the other and, Arif et al. reported that moderate consumption has a protective effect on overweight and obesity.[68] However, we did not found a statistical significance for that, perhaps due to the fact that our study include more non-drinkers and by the use of a distinct BMI cut offs. Thus, more studies are needed to explore the association between alcohol intake and overweight and obesity in older adults.

Regarding sarcopenia, it was found an inverse association with overweight. Usually, a low BMI is predictive of a higher risk of sarcopenia in older adults.[69, 70] Yet, not always sarcopenic people have a low BMI which leads to emergence of sarcopenic obesity. These individuals though have a great amount of fat tissue have low levels of muscle mass and/or strength due to physiological alterations occurred with age. Thus, the single use of BMI may be masking cases of sarcopenia in the older adults.[71, 72]

Although we have not found an association between age and overweight, previous researches demonstrate that more advanced ages were negatively associated with overweight[50, 52, 55, 59, 73] which can be explained in part by the increased mortality of obese older adults at earlier ages. [50, 52] According to marital status we also not found a significant relation, however it has been seen that married people are more likely to be overweight. [55, 73]

The main strengths of the present study are the large number of individuals who participated, resulting in a representative sample of Portuguese older adults, and the use of standardized measures to collect anthropometric data. Besides, as far as we know, this is the first study in Portugal to evaluate the association between demographic and lifestyle factors with overweight in older adults, using the BMI classification proposed by Lipschitz for these ages. However, the choice of this classification also constitutes a limitation, in the sense of comparing with other results that utilize different cut offs points for BMI. Yet, even using this classification, we found similar associations with most of the factors reported in other studies that have used other BMI cutoff points. Other possible limitation is the strict inclusion/exclusion criteria, which may possible have resulted in a sample with a better-than-average health and nutritional status.

Previous research found that cutoff points established by Lipschitz cover a large range of underweight individuals.[74-76] Other study[77] found that BMI > 27 kg/m^2 presented more sensitivity and specificity and verified a higher concordance between BMI > 27kg/m^2 and body fat mass percentage, comparing with BMI ≥ 30 kg/m^2 proposed by WHO, to assess obesity.

Considering the body changes of aging, maybe it is more interesting for clinicians to use a higher cutoff value for underweight. Regarding obesity, probably a BMI>27 kg/m^2 can be more useful as a parameter of alertness, although the intervention in terms of treatment should be considered from a BMI ≥ 30 kg/m^2, due to some adverse effects that may appear by weight loss in this age group.[9], Thus, it is necessary to develop further researches among older adults combining BMI with other anthropometric measurements, in order to reach more reliable diagnoses and to establish the most appropriate intervention.

Conclusion

The present study shows a large prevalence of overweight and obesity among Portuguese older adults (67.9%) and its association with several factors. Education ≥5 years, being men, at risk of undernutrition or undernourished, to smoke, being sarcopenic and cognitive impairment decreased overweight risk, whereas poor self-perception of health and excessive alcohol consumption increased overweight risk. Our data reveal the need to develop effective public health programs and to improve health literacy skills, to improve a better quality of life in the older adults. In addition to the increased risk of comorbidities, overweight in the older adults also leads to an increase of health care costs, emphasizing even more the need of prevent programs.

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Appendix A

Table 1 - Baseline sociodemographic, clinical and nutritional characteristics of 1496 older Portuguese ≥ 65 years old participating in a cross-sectional observational study according to nutritional status*

	Underweight BMI < 22.0 kg/m² (n=63)	**Normal weight BMI=22.0 – 27.0 kg/m² (n=417)**	**Overweight BMI > 27.0 kg/m² (n=1016)**	**p**
Sex, n (%)				
Women	36 (57.1%)	212 (50.8%)	623 (61.3%)	**0.001**
Men	27 (42.9%)	205 (49.2%)	393 (38.7%)	
Age, years, n (%)				
65-69	13 (20.6%)	117 (28.1%)	280 (27.6%)	0.760
70-74	18 (28.6%)	96 (23.0%)	258 (25.4%)	
75-79	12 (19.0%)	94 (22.5%)	215 (21.2%)	
≥ 80	20 (31.7%)	110 (26.4%)	263 (25.9%)	
Regional area, n (%)				
North	14 (22.2%)	130 (31.2%)	326 (32.1%)	**0.037**
Centre	19 (30.2%)	104 (24.9%)	265 (26.1%)	
Lisbon Metropolitan Area	16 (25.4%)	124 (29.7%)	244 (24.0%)	
Alentejo	4 (6.3%)	33 (7.9%)	99 (9.7%)	
Algarve	8 (12.7%)	13 (3.1%)	43 (4.2%)	
Madeira	1 (1.6%)	5 (1.2%)	24 (2.4%)	
Azores	1 (1.6%)	8 (1.9%)	15 (1.5%)	
Residence, n (%)				
Home	60 (95.2%)	401 (96.2%)	965 (95.0%)	0.629
Institution	3 (4.8 %)	16 (3.8%)	51 (5.0%)	
Education, years, n (%)				
0	9 (14.3%)	46 (11.0%)	156 (15.4%)	**0.020**
1-3	15 (23.8%)	71 (17.0%)	198 (19.5%)	
4	28 (44.4%)	207 (49.6%)	509 (50.1%)	
≥ 5	11 (17.5%)	93 (22.3%)	153 (15.1%)	
Marital status, n (%)				
Single, divorced or widowed	22 (34.9%)	210 (50.4%)	469 (46.2%)	0.059
Married or common-law marriage	41 (65.1%)	207 (49.6%)	546 (53.8%)	
Household income, €, n (%)				
≤ 499	13 (20.6%)	65 (15.6%)	169 (16.6%)	0.594
500 – 999	12 (19.0%)	86 (20.6%)	207 (20.4%)	
≥ 1000	3 (4.8%)	55 (13.2%)	117 (11.5%)	
Does not know or does not declare	35 (55.6%)	211 (50.6%)	523 (51.5%)	
Cognitive performance (MMSE), n (%)				
Normal	57 (90.5%)	381 (91.4%)	961 (94.6%)	**0.048**
Impairment	6 (9.5%)	36 (8.6%)	55 (5.4%)	
Self-perception of health, n (%)				
Very good/good	23 (36.5%)	162 (38.9%)	292 (28.8%)	**0.004**
Moderate	30 (47.6%)	189 (45.4%)	513 (50.6%)	
Bad/Very bad	10 (15.9%)	65 (15.6%)	208 (20.5%)	

Nutritional status (MNA-SF), n (%)				
Not undernourished	34 (54.0%)	346 (83.0%)	877 (86.3%)	**<0.001**
Risk of undernutrition and undernutrition	29 (46.0%)	71 (17.0%)	139 (13.7%)	
Physical activity (IPAQ), kcal/week, n (%)**				
Normal	23 (36.5%)	90 (21.6%)	310 (30.5%)	**0.001**
Low	40 (63.5%)	327 (78.4%)	706 (69.5%)	
Smoking habits, n (%)				
No	49 (77.8%)	392 (94.0%)	987 (97.1%)	**<0.001**
Yes	14 (22.2%)	25 (6.0%)	29 (2.9%)	
Alcoholic beverages consumption, n (%)				
None	49 (77.8%)	250 (60.1%)	651 (64.1%)	**0.002**
Moderate (women=1/day, men=1 or 2/day)	9 (14.3%)	133 (32.0%)	247 (24.3%)	
Excessive (women≥2/day, men≥3/day)	5 (7.9%)	33 (7.9%)	117 (11.5%)	
Sarcopenia, n (%)				
Normal	37 (58.7%)	329 (79.3%)	953 (94.0%)	**<0.001**
Sarcopenic	26 (41.3%)	86 (20.7%)	61 (6.0%)	
Frailty, n (%)				
No	42 (68.9%)	336 (81.8%)	780 (78.3%)	0.052
Yes	19 (31.1%)	75 (18.2%)	216 (21.7%)	

*Values may not add up 100.0% due to rounding up. Number of missing data: marital status: n=1; self-perception of health: n=4; alcoholic beverages consumption: n=2; sarcopenia: n=4; frailty: n=28.

**Normal physical activity levels defined as ≥383 kcal/week (men) and ≥270 kcal/week (women); low physical activity levels defined as <383 kcal/week (men) and <270 kcal/week (women).

Appendix B

Table 2 - Factors associated with overweight (BMI > 27 kg/m^2) by logistic regression for 1485 older Portuguese ≥ 65 years participating in a cross-sectional observational study

	Crude OR* (95% CI)**	**p**	**Adjusted OR (95% CI)**	**p**
Sex, n (%)				
Women	1	-	1	-
Men	**0.674 (0.542 – 0.839)**	**<0.001**	0.766 (0.579 – 1.014)	0.062
Age, years, n (%)				
65-69	1	-	1	-
70-74	1.051 (0.776 – 1.423)	0.749	1.022 (0.737 – 1.417)	0.896
75-79	0.942 (0.689 – 1.287)	0.706	0.867 (0.612 – 1.230)	0.425
≥ 80	0.939 (0.699 – 1.262)	0.678	0.778 (0.547 – 1.106)	0.162
Regional area, n (%)				
North	1	-	1	-
Centre	0.952 (0.712 – 1.272)	0.738	0.983 (0.715 – 1.351)	0.916
Lisbon Metropolitan Area	0.770 (0.579 – 1.024)	0.073	1.052 (0.758 – 1.461)	0.762
Alentejo	1.182 (0.772- 1.809)	0.441	1.237 (0.784 – 1.952)	0.360
Algarve	0.904 (0.518 – 1.579)	0.724	1.232 (0.665 – 2.283)	0.508
Madeira	1.767 (0.707 – 4.415)	0.223	1.737 (0.673 – 4.481)	0.253
Azores	0.736 (0.315 – 1.721)	0.480	1.677 (0.651 – 4.318)	0.284
Residence, n (%)				
Home	1	-	1	-
Institution	1.282 (0.748 – 2.197)	0.365	1.278 (0.687 – 2.379)	0.439
Education, years, n (%)				
0	1	-	1	-
1-3	0.812 (0.545 – 1.209)	0.304	0.758 (0.487 – 1.181)	0.221
4	0.764 (0.541 – 1.077)	0.124	0.708 (0.479 – 1.046)	0.083
≥ 5	**0.519 (0.349 – 0.770)**	**0.001**	**0.581 (0.366 – 0.924)**	**0.022**
Marital status, n (%)				
Single, divorced or widowed	1	-	1	-
Married or common-law marriage	1.089 (0.876 – 1.354)	0.442	1.031 (0.794 – 1.339)	0.819
Cognitive performance (MMSE), n (%)				

Normal	1	-	1	-
Impairment	**0.597 (0.393 – 0.906)**	**0.015**	**0.535 (0.336 – 0.853)**	**0.009**
Self-perception of health, n (%)				
Very good/good	1	-	1	-
Moderate	**1.484 (1.164 – 1.892)**	**0.001**	1.217 (0.934 – 1.585)	0.146
Bad/Very bad	**1.757 (1.274 – 2.424)**	**0.001**	**1.656 (1.143 – 2.398)**	**0.008**
Nutritional status (MNA-SF), n (%)				
Not undernourished	1	-	1	-
Risk of undernutrition and undernutrition	**0.602 (0.453 – 0.800)**	**<0.001**	**0.495 (0.358 – 0.683)**	**<0.001**
Physical activity (IPAQ), kcal/week, n (%)				
Normal	1	-	1	-
Low	**0.701 (0.546 – 0.900)**	**0.005**	**0.609 (0.454 – 0.816)**	**0.001**
Smoking habits, n (%)				
No	1	-	1	-
Yes	**0.332 (0.203 – 0.544)**	**<0.001**	**0.360 (0.211 – 0.615)**	**<0.001**
Alcoholic beverages consumption, n (%)				
None	1	-	1	-
Moderate (women=1/day, men=1 or 2/day)	0.799 (0.624 – 1.023)	0.076	0.982 (0.718 – 1.343)	0.908
Excessive (women≥2/day, men≥3/day)	1.414 (0.957 – 2.090)	0.082	**1.805 (1.152 – 2.829)**	**0.010**
Sarcopenia, n (%)				
Normal	1	-	1	-
Sarcopenic	**0.209 (0.150 – 0.292)**	**<0.001**	**0.194 (0.135 – 0.279)**	**<0.001**

*OR: Odds ratio.
**CI: Confidence interval.